Autonomic nervous system

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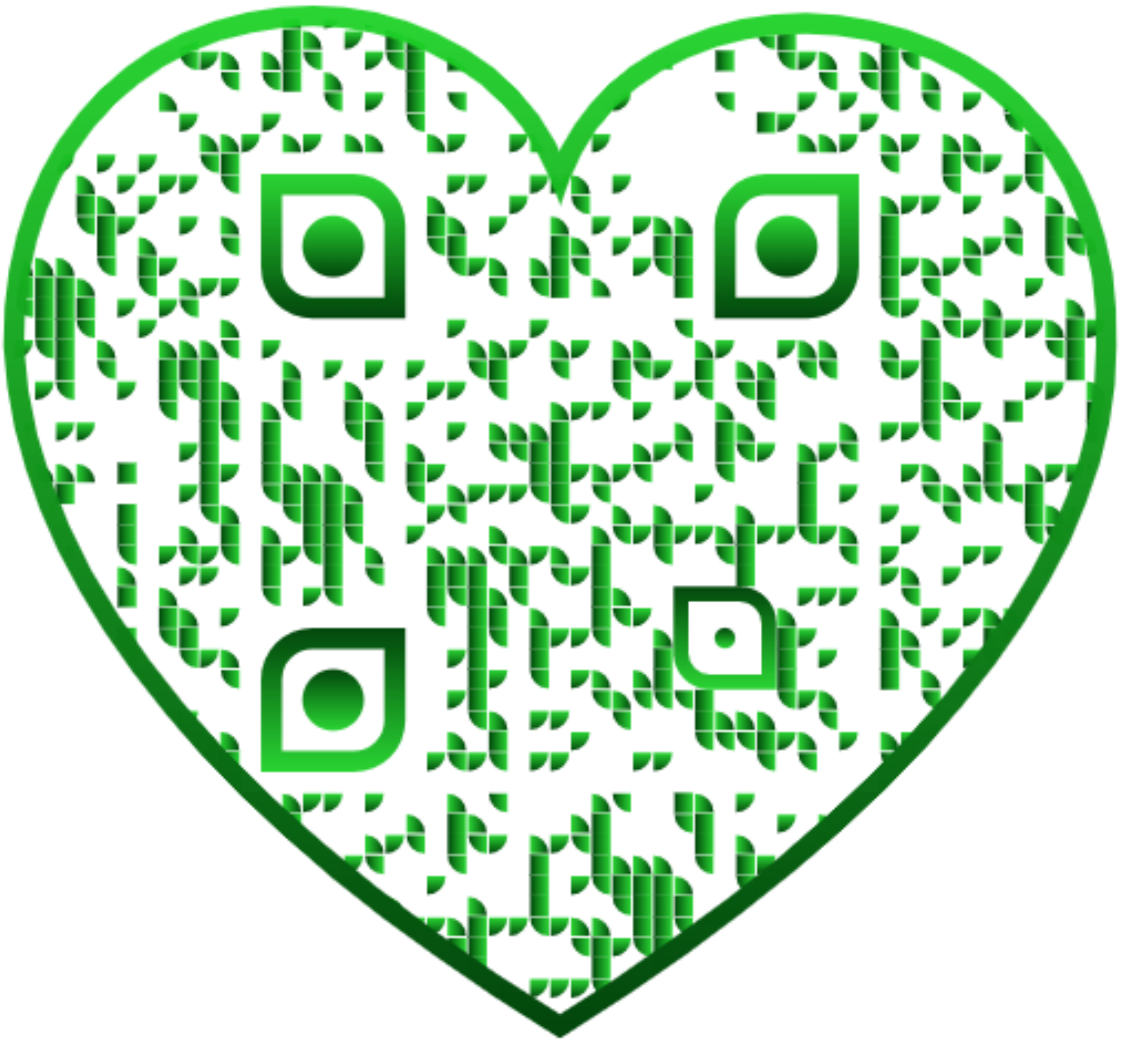

- *Autonomic nervous system (A.N.S.) is the part of the nervous system that regulates the activity of the viscera, glands, heart and blood vessels.*
- *It is also called the visceral or involuntary nervous system.*

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- *The voluntary functions are controlled by another part of the nervous system called the somatic nervous system (central nervous system).*

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- *Anatomical divisions of the nervous system:*
- *A) Central nervous system (CNS):*
- *1- Brain :*
- *a) Cerebrum.*
- *b) Cerebellum.*
- *c) Brain stem.*
- *2- Spinal cord (31 segments).*

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- ***B) Peripheral nervous system:***
- *This consists of the peripheral nerves that arise from the central nervous system, and they include:*
- *1- The cranial nerves.*
- *2- The spinal nerves.*
- *3- The autonomic nerves:*
- *a) Sympathetic nerves.*
- *b) Parasympathetic nerves.*

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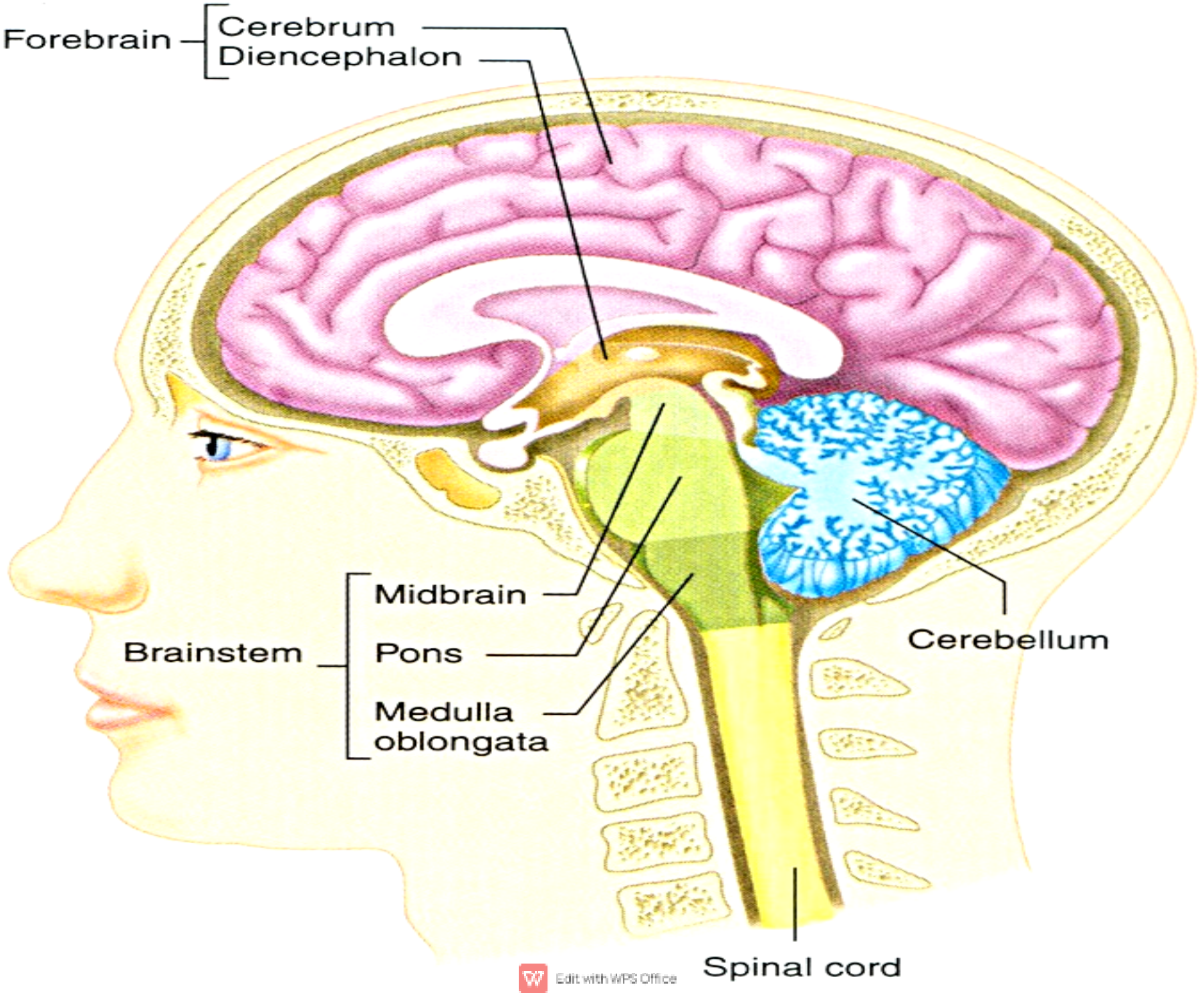

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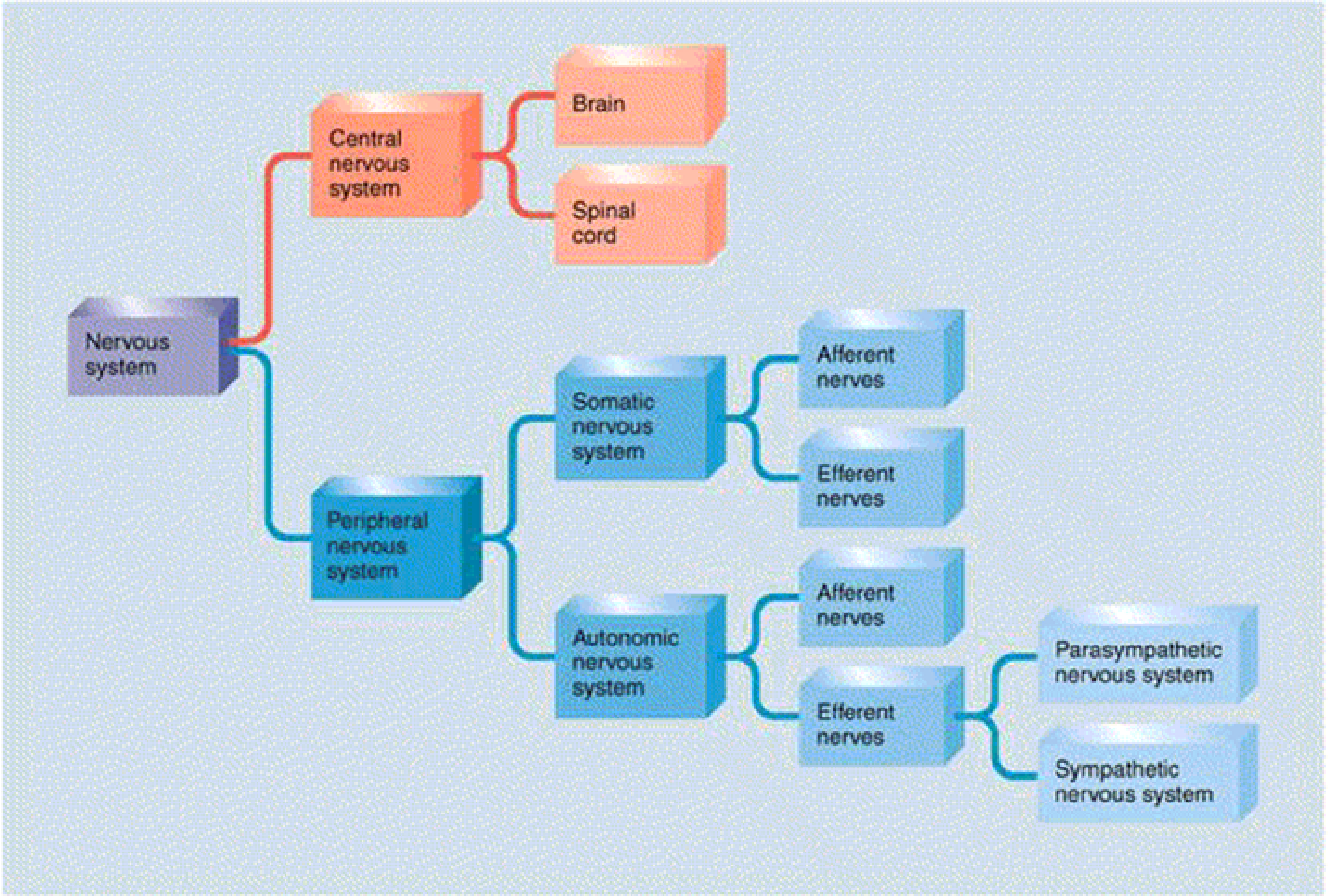
► Major Divisions of the Nervous System



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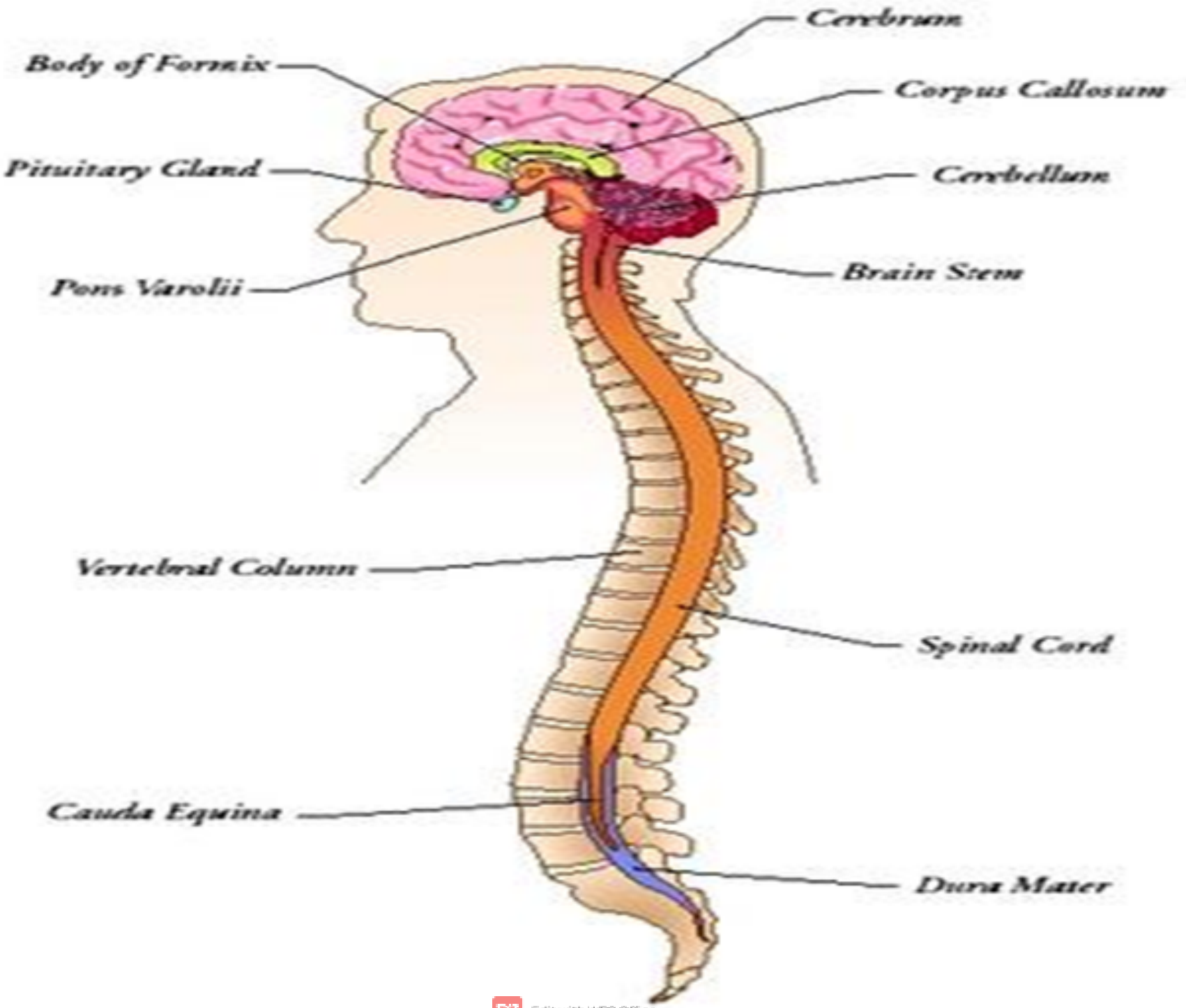

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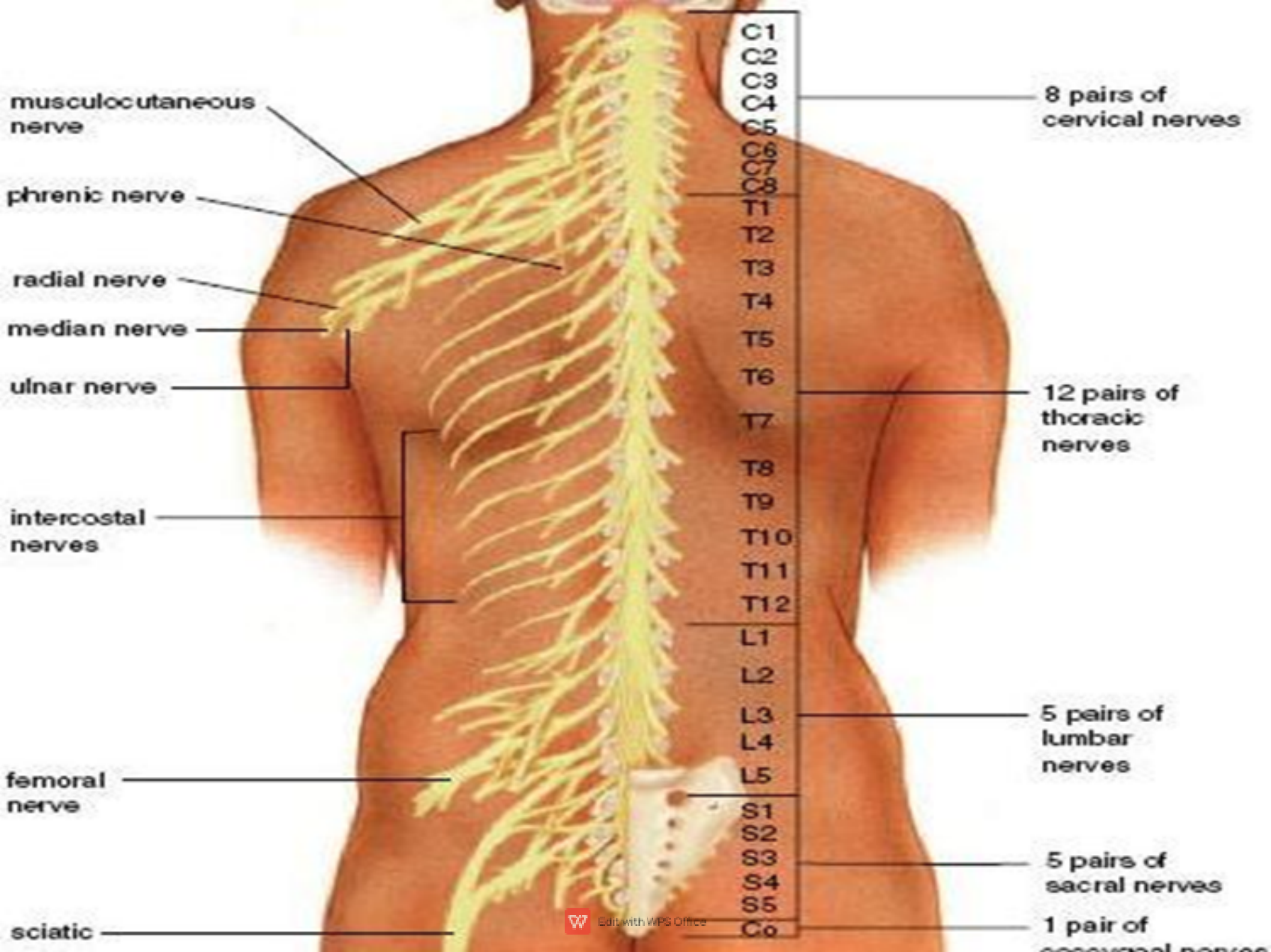
musculocutaneous nerve
phrenic nerve
radial nerve
median nerve
ulnar nerve
intercostal nerves
femoral nerve
sciatic
C1
C2
C3
C4
C5
C6
C7
C8
T1
T2
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L1
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L4
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S1
S2
S3
S4
S5
Co
8 pairs of cervical nerves
12 pairs of thoracic nerves
5 pairs of lumbar nerves
5 pairs of sacral nerves
1 pair of

- *1- The sympathetic nervous system:*
- *This arises from the lateral horn cells (LHCs) of all thoracic and upper 3 lumbar segments of the spinal cord (thoracolumbar outflow).*

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- ***2-The parasympathetic nervous system:***
- *This arises from LHCs of the 2nd, 3rd and 4th sacral segments of the spinal cord as well as from the nuclei of certain cranial nerves, which include:*
- *a) The 3rd cranial nerve (oculomotor).*
- *b) The 7th cranial nerve (facial).*
- *c) The 9th cranial nerve (glossopharyngeal).*
- *d) The 10th cranial nerve (vagus).*

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- ***Reflex action:***
- *It is an involuntary response to a stimulus.*
- *It is the functional unit of the nervous system.*
- *1- Somatic reflex actions: regulate the activity of skeletal muscles.*
- *2- Autonomic reflex actions: regulate the activity of the viscera.*

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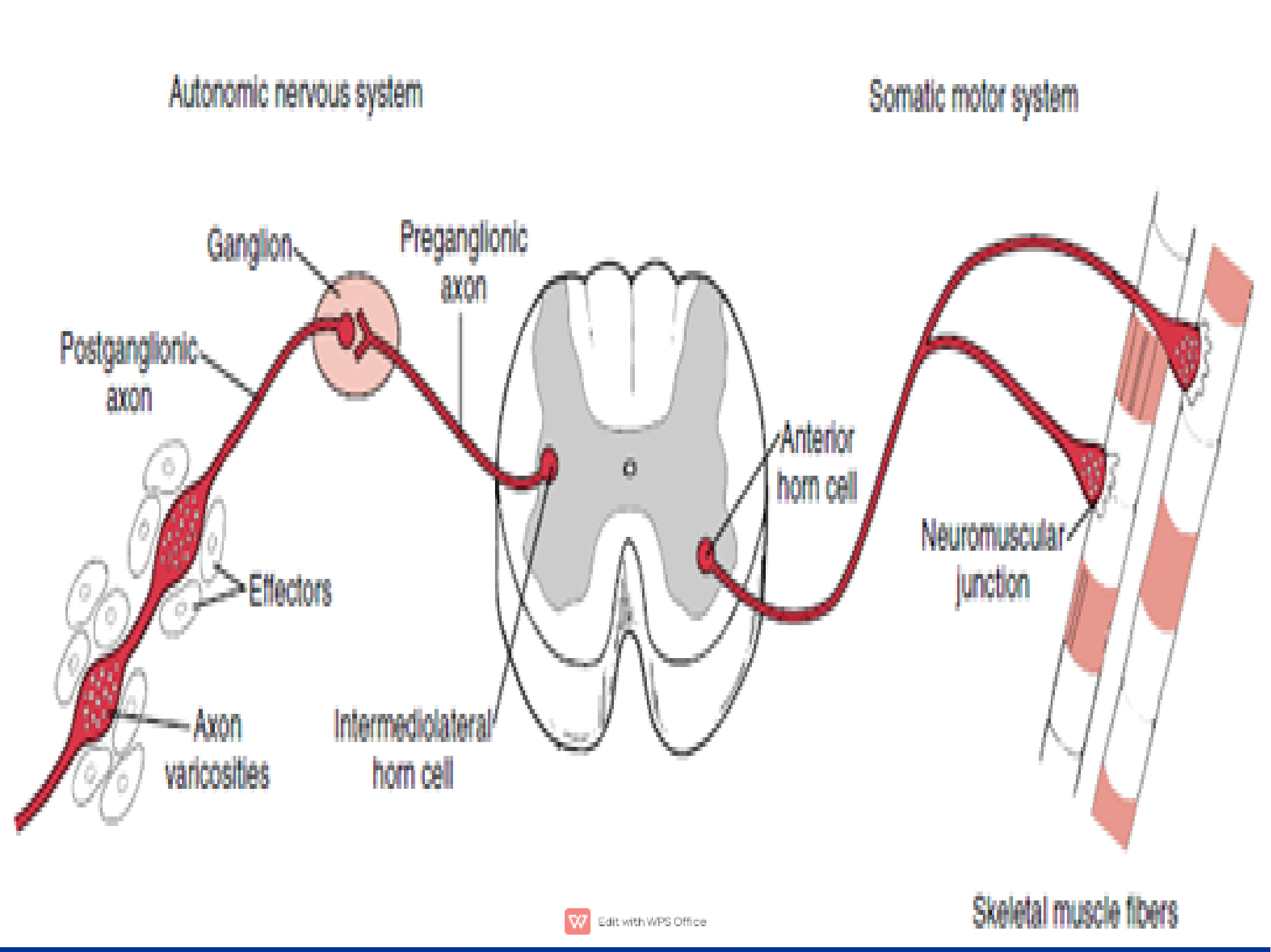

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- ***Autonomic ganglia***
- *Autonomic ganglion is a collection of nerve cells outside the C.N.S.*
- *It contains the postganglionic neurons.*
- *Preganglionic fibers may pass through several autonomic ganglia but it relays only in one ganglion.*

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- ***Types of autonomic ganglia:***
- ***1- Lateral (paravertebral) ganglia:***
  These ganglia are the main sites for relay of preganglionic sympathetic fibers.
- ***2- Collateral (prevertebral) ganglia:***
  These are present mainly in the abdomen in close relation to the aorta. These ganglia are sympathetic.

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- *3- Terminal ganglia:*
- *These are present near or in the walls of the effector organs. These ganglia are mostly the sites for relay of preganglionic parasympathetic fibers.*

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- ***Functions of autonomic ganglia:***
- ***Distributing centre:*** *the preganglionic fibers arise from limited regions of brain stem and spinal cord. By the aid of autonomic ganglia, each preganglionic fiber diverges to average 8-9 postganglionic neurons.*

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- ***The sympathetic nervous system***
- ***The sympathetic nervous system can be divided into 4 divisions:***
- ***1- Cervical.***
- ***2- Cardio-pulmonary.***
- ***3- Splanchnic.***
- ***4- Somatic.***

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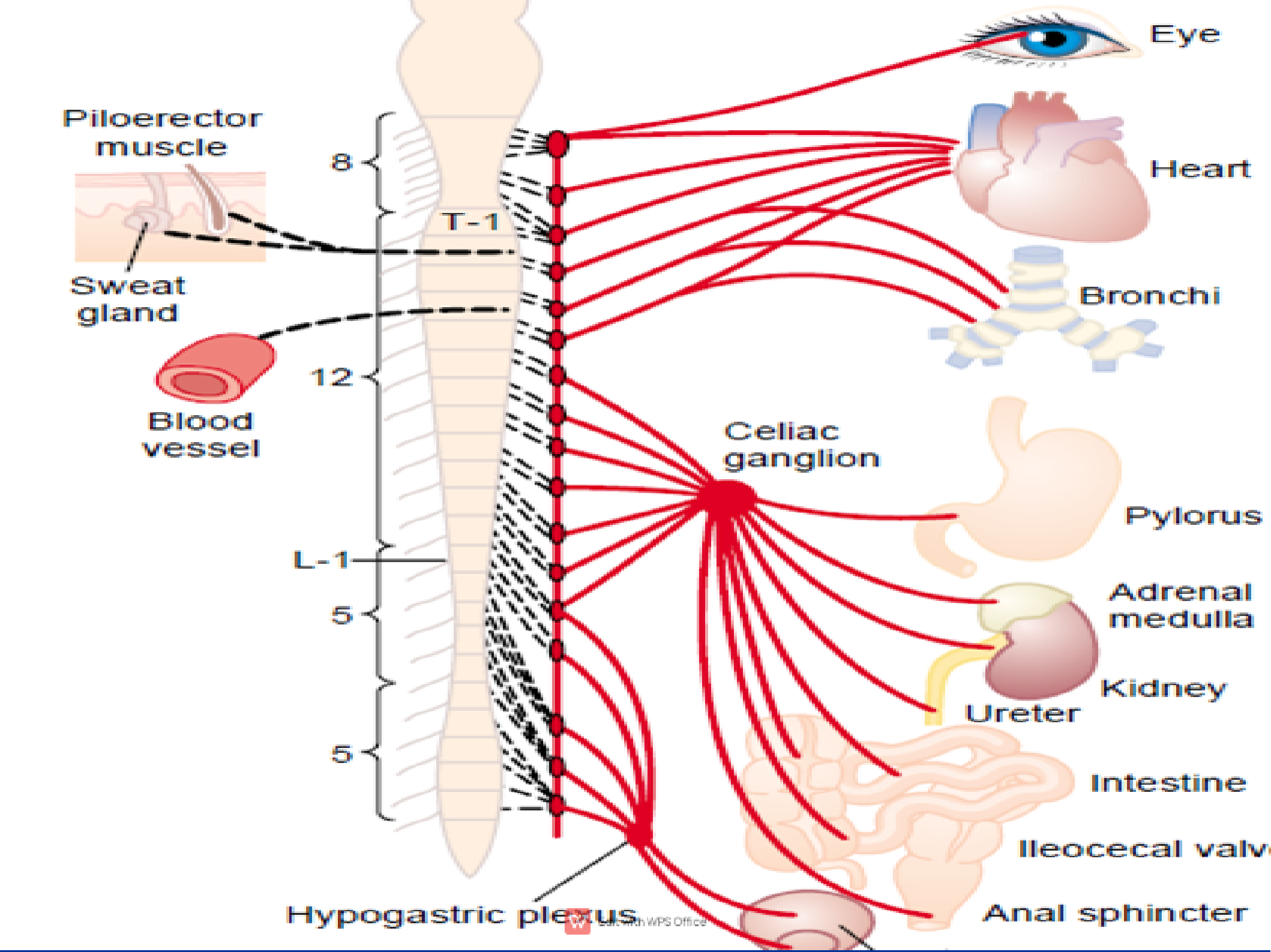
Piloerector muscle
Sweat gland
Blood vessel
8
T-1
12
L-1
5
5
Eye
Heart
Bronchi
Celiac ganglion
Pylorus
Adrenal medulla
Kidney
Ureter
Intestine
Ileocecal valve
Anal sphincter
Hypogastric plexus

- ***1- Cervical division***
- *This division supplies different structures in the region of the **head and neck.***
- ***a) Origin:** preganglionic fibers arise from the lateral horn cells (L.H.Cs) of the upper 2 thoracic segments.*
- ***b) Relay:** in the superior cervical sympathetic ganglion.*

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- ***c) Functions:***
- ***1- Eye:***
  - *a) Contraction of the dilator pupillae muscle leading to pupil dilatation (mydriasis).*
  - *b) Contraction of muscles in the eyelids (called superior and inferior tarsal muscles)* → ***lid retraction*** → ***widening of the palpebral fissure.***

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- *c) Contraction of Muller's muscle behind the eyeballs → exophthalmos.*
- *d) Vasoconstriction (VC) of the blood vessels of the eye.*
- *e) Relaxation of the ciliary muscle during far vision.*

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- ***2- Salivary glands:***
- *a) Trophic secretion (small in volume, viscous and rich in organic material).*
- ***b) Motor to the myoepithelial cells surrounding the acini → squeeze saliva.***
- *c) Vasoconstriction of the salivary blood vessels.*

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- ***3-Skin:***
- ***a) Vasoconstriction of the cutaneous blood vessels.***
- ***b) Sweat secretion.***
- ***c) Hair erection as a result of contraction of certain muscles in the skin called pilomotor muscles.***
- ***4- Brain:***
- ***Slight vasoconstriction to the cerebral blood vessels.***

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- ***Horner's syndrome***
- *An injury to the cervical sympathetic nerve fibers produces a syndrome (group of symptoms) on the same side called Horner's syndrome.*
- ***The symptoms of Horner's syndrome:***
- ***1- Ptosis:*** *drooping of the upper eyelid due to paralysis of the superior tarsal muscle.*

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- *2- Miosis (pupilloconstriction) due to paralysis of the dilator pupillae muscle.*
- *3-Anhydrosis (absence of sweat secretion).*
- *4-Vasodilatation (VD) due to loss of sympathetic V.C effect, so it becomes warmer and more red than the healthy side.*
- *5- Enophthalmos (sinking of the eyeball backward in the orbit) due to paralysis of Muller's muscle.*

- *2- Cardiopulmonary division*
- *This division supplies the heart and lungs.*
- *a)Origin: preganglionic fibers arise from L.H.Cs of the upper 4 thoracic segments.*
- *b) Relay: in the cervical and upper 4 thoracic lateral ganglia.*

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- *c)Functions:*
- *1-heart:*
- *a) Stimulates all properties of the cardiac muscle.*
- *b) Vasodilatation of the coronary vessels (indirect effect).*
- *c) Increases the O2 consumption of the heart.*

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- *2- Lungs:*
- *a)Inhibits mucus secretion of bronchial glands.*
- *b) Produces bronchodilatation.*
- *c)V.C of the pulmonary vessels.*

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- ***3- Splanchnic (visceral) division***
- *This division supplies different **abdominal and pelvic viscera.***
- ***a) Sympathetic supply to the abdomen (greater splanchnic nerve):***
- ***Origin:** preganglionic fibers arise from the L.H.Cs of the lower 6 thoracic segments.*
- ***Relay:** in the collateral ganglia in the abdomen.*

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- ***Functions:***
  - *1- V.C of the majority of the arterioles in the stomach, small intestine, proximal part of the large intestine, kidney, liver and pancreas.*
  - *2- Relaxation of the walls of the stomach, small intestine and proximal part of the large intestine and contraction their corresponding sphincters.*

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- *3- Contraction of the smooth muscle in the capsule of spleen→ squeeze the stored blood into circulation.*
- *4- Stimulation of glycogenolsis in the liver→ increased blood glucose level.*
- *5- Stimulation of adrenal medulla to secrete its hormones (catecholamine).*
- *6- Inhibits insulin hormone secretion.*

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- ***b) Sympathetic supply to the pelvis (lesser splanchnic nerve):***
- ***Origin:*** *preganglionic fibers arise from the L.H.Cs of the upper 3 lumber segments.*
- ***Relay:*** *in the collateral ganglia in the abdomen.*

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- ***Functions:***
  - *1- Relaxation of the urinary bladder wall and contraction of the internal urethral sphincter→ urine retention.*
  - *2- Relaxation of the walls of the rectum and distal part of the large intestine and contraction of the internal anal sphincter→ retention of feces.*

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- *V.C of blood vessels in the pelvic viscera and erectile tissues → inhibition of erection and shrinkage of these organs.*
- *4- In the male, it causes contraction of the smooth muscle in the vas deferens, seminal vesicles and prostate→ ejaculation of semen.*
- *5- In the females, it produces variable effects on the uterus (contraction or relaxation) depending on ……..*

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4- Somatic division

- This division of the sympathetic nervous system accompanies the **somatic nerves** and supplies with them the **skin and skeletal muscles.**
- **a) Sympathetic supply to the upper limbs:**
- **Origin:** preganglionic fibers arise from LHCs of the thoracic 4-8 segments.
- **Relay:** in the cervical and upper 4 thoracic ganglia.

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- ***Functions:***
- ***1-Skin:*** *V.C, sweat secretion and erection of hair.*
- ***2-Skeletal muscles:***
- *a) V.D of skeletal muscles blood vessels.*
- *b) Stronger contraction, delayed fatigue and rapid recovery (Orbelli effect).*

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- ***a) Sympathetic supply to the lower limbs:***
- ***Origin:*** *preganglionic fibers arise from LHCs of the thoracic 10 - 12 segments and lumber 1-2 segments.*
- ***Relay:*** *in the lumber and sacral ganglia.*
- ***Functions:***
- *The same as in the upper limbs.*

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